International Emerging Technology Symposium

Chicago, IL

May 11, 2016

Water Quality, Water Savings and the Water-Energy Nexus Three Issues, One Solution?

By

Part 3 – **Tim Keane**

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2004 12

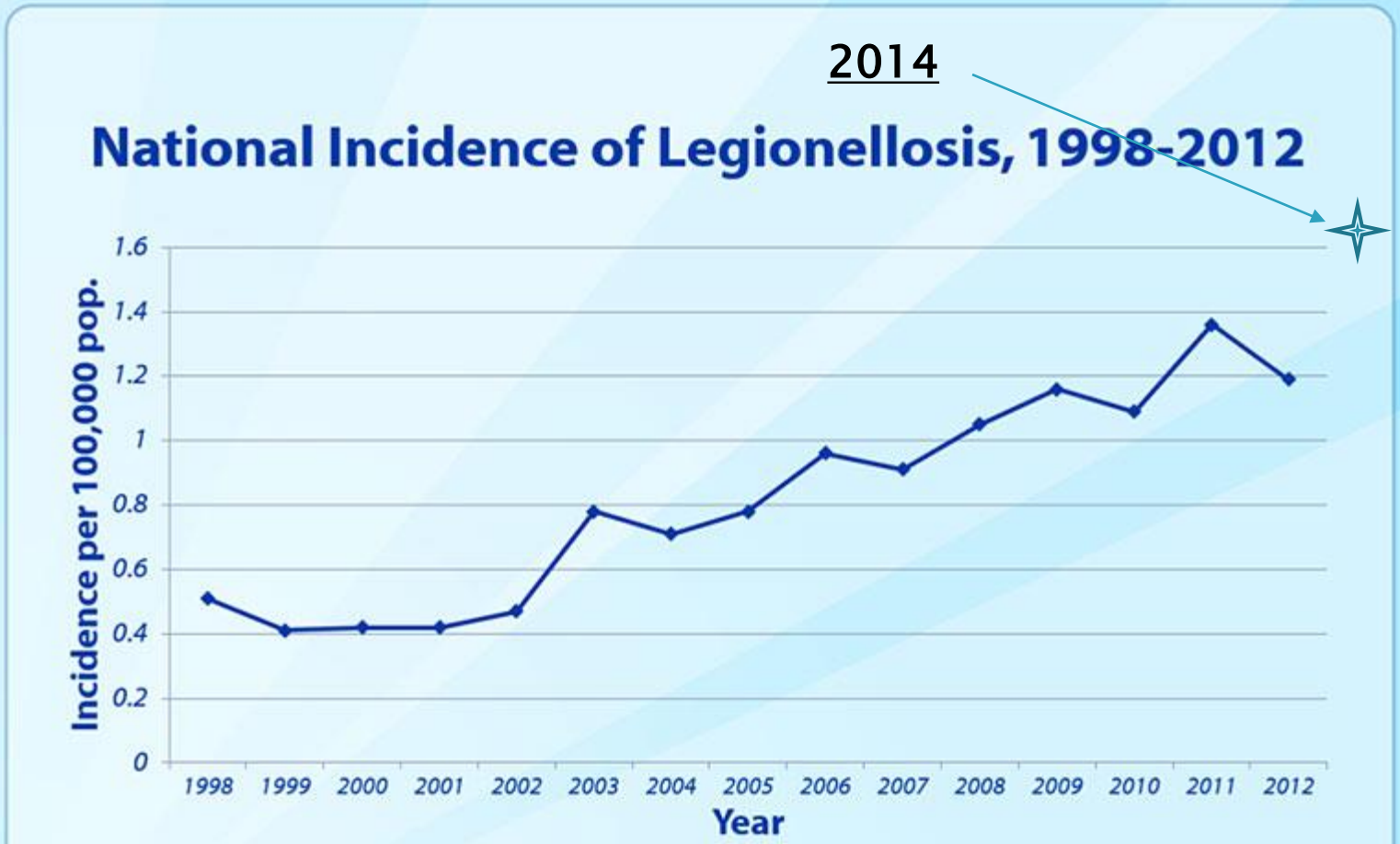
CDC – Surveillance for Waterborne Disease Outbreaks Associated with Drinking Water — 2001-2002 pub date 2004

- ✓ For the first time, this *MMWR Surveillance Summary* includes drinking water-associated outbreaks of Legionnaires disease (LD); six outbreaks of LD occurred during 2001--2002.

CDC – Surveillance for Waterborne Disease Outbreaks Associated with Drinking Water — 2011–2012 pub date 2013

- ✓ *Legionella* was implicated in 66% outbreaks, 89% hospitalizations, and 100% deaths.
- ✓ Although the total number of drinking water–associated outbreaks has remained nearly constant, *Legionella* has caused increasing proportions of drinking water–associated outbreaks (33%, 60%, and 66% during each of these time periods, respectively). This pattern has been driven by the increasing proportion of *Legionella* outbreaks among those in community water systems (60%, 76%, and 84% during each of these time periods, respectively).

CDC Data


2014
National Incidence of Legionellosis, 1998-2012
Incidence per 100,000 pop.
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Year

Key Issues

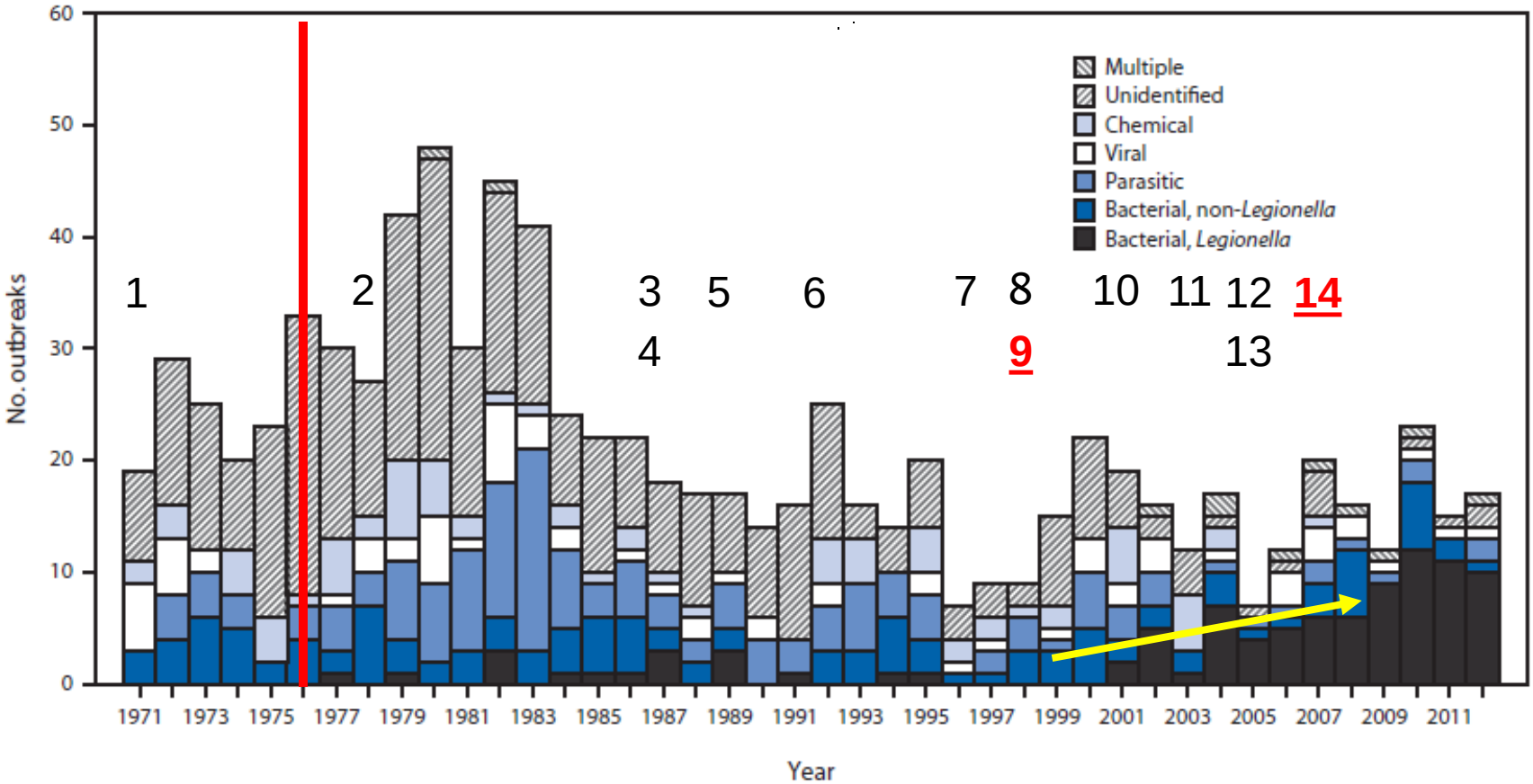
- Why OPPPs, Why Now?
- Taking Responsibility for OPPPs
- OPPPs in green buildings

CDC Reported DW Outbreaks 1971 – 2012

1	1970	Water Consumption Flattens
2	1979	CPSC recommends 130°F home water heaters
3	1987	SD 1st US Legionella
4	1987	NAECA Nat'l Appliance Energy Conserv Act
5	1989	ASHRAE 90.1
6	1992	EPA NAECA
7	1997	ACHD Legionella Guidelines

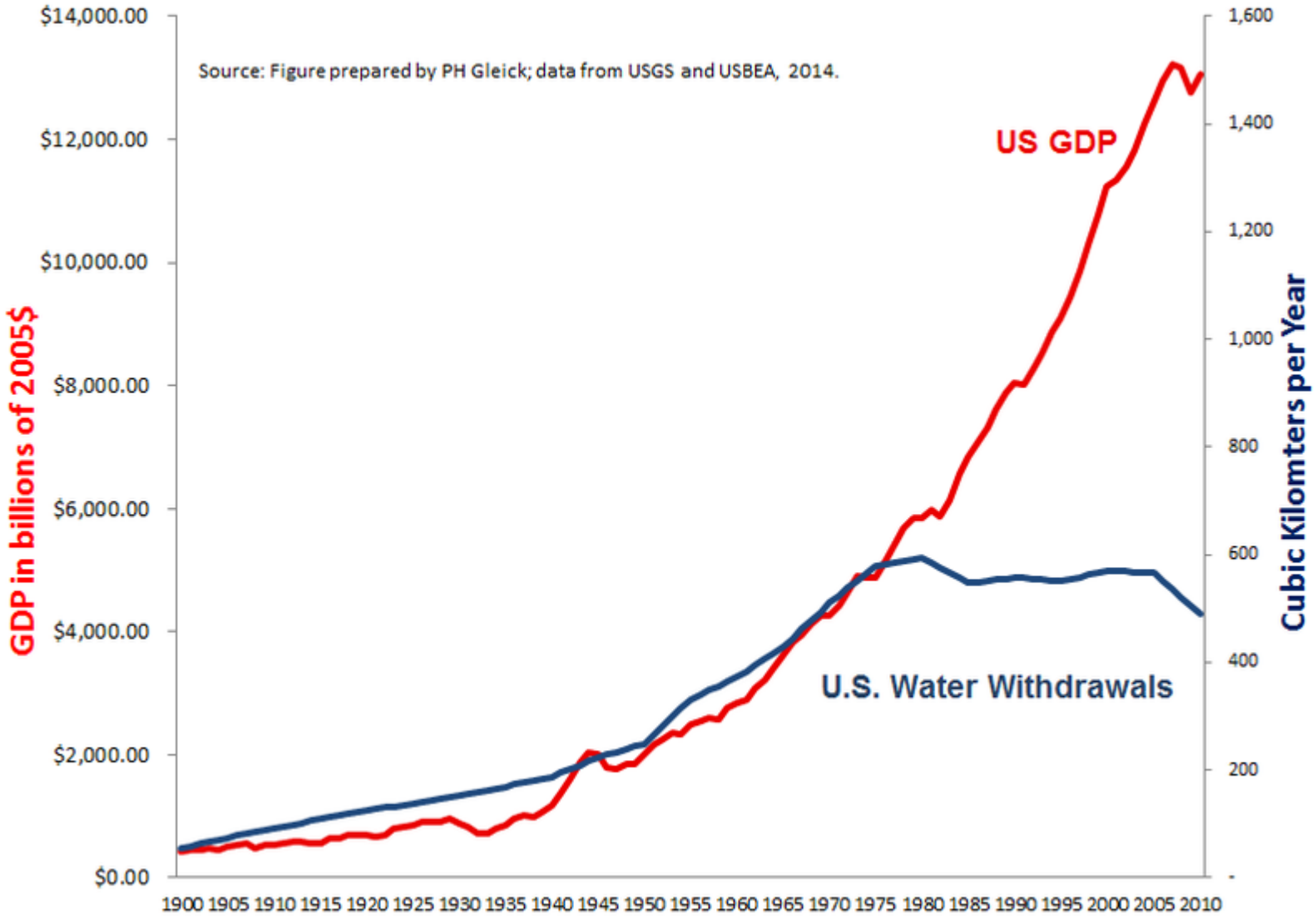
8	1998	OSHA Legionella Guideline
9	1998	USGBC LEED
10	2001	Joint Commission Standard
11	2003	1st CDC guidelines
12	2004	1st CDC Legionella MMWR
13	2004	Wisconsin Plumbing Code
14	2007	EPA Water Sense

FIGURE. Etiology of 885 drinking water–associated outbreaks, by year — United States, 1971–2012*



1970 46

U.S. Water Consumption Flat since 1970



1989 27

ASHRAE 90.1 "Energy Standard for Buildings Except Low-Rise Residential Buildings"

11.4.5.2 Lavatories in public facility restrooms (such as those in service stations, airports, train terminals, and convention halls) shall meet all of the following requirements:

(a) **Flow Rate,** Be equipped to limit the flow of hot water to

1. either a maximum of 0.50 gpm,
2. or 0.75 gpm if a device or fitting is used that limits the period of water discharge, such as a foot switch or fixture occupancy sensor,
3. or 2.5 gpm if equipped with a self-closing valve.

(b) **Total Flow,**

1. Either be equipped with a foot switch or fixture occupancy sensor or similar device
2. or be equipped with a device or fitting that limits delivery to a maximum of 0.25 gallons per cycle of hot water for circulating systems and a maximum of 0.50 per cycle gallons for non-circulating systems. Lavatories for physically handicapped persons need not be so equipped.

(c) **Temperature,** Limit the outlet temperature to 110°F maximum.

2009 7

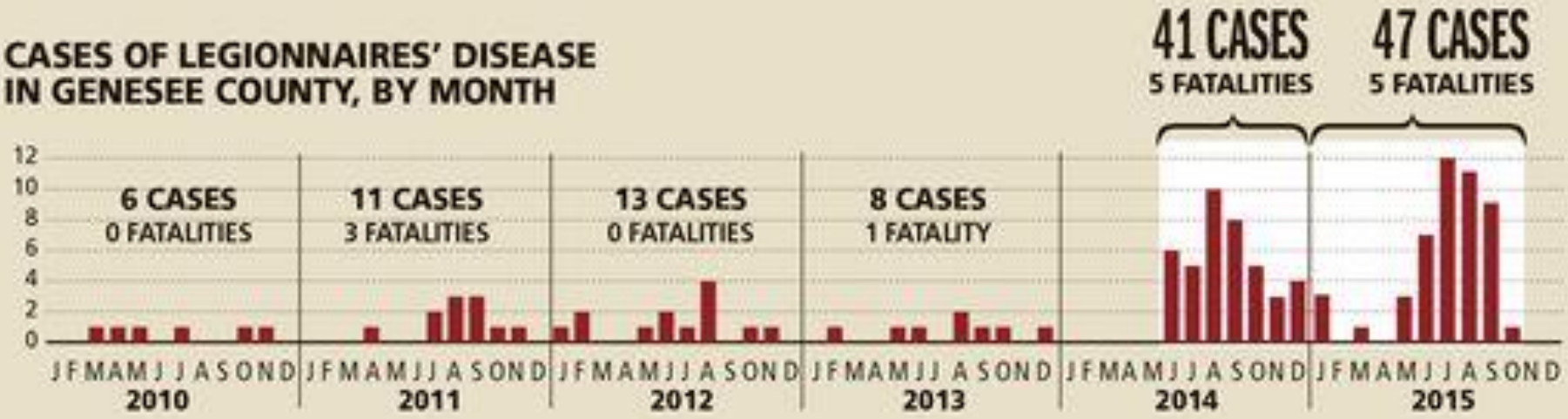
VHA Domestic Hot Water Temperature Limits for Legionella Prevention and Scald Control

- If a facility uses hot water storage tanks, raise the water temperature of all domestic hot water storage tanks to a minimum of 140 degrees Fahrenheit (°F) to prevent growth of Legionella. A master thermostatic mixing valve assembly must be installed on the discharge side to reduce water temperature to 130°F before distribution, with a maximum decrement in water temperature of 10°F (120°F) at the tap.

SPIKE IN LEGIONNAIRES' DISEASE IN GENESEE COUNTY

The State of Michigan reported a spike in cases of Legionnaires' disease in Genesee County from June 2014 to October 2015 — a total of 88. There were 10 reported fatalities associated with this increase.

CASES OF LEGIONNAIRES' DISEASE IN GENESEE COUNTY, BY MONTH



LEGIONNAIRES' DISEASE: PNEUMONIALIKE DISEASE CAUSED BY BACTERIA

Legionnaires' disease is caused by the Legionella bacterium, which is usually found in water. The disease is associated with manmade water environments including hot tubs, large plumbing systems and cooling towers. Many infections go undiagnosed or unreported because symptoms are similar to pneumonia.

HISTORY
The disease got its name after an outbreak at the 1976 Philadelphia convention of the American Legion.

SYMPTOMS
Symptoms include fever, chills and cough.

EXPOSURE AND TRANSFER
Infection occurs when a person breathes in water vapor containing the bacteria; it does not transfer between people.

INCUBATION PERIOD
2 to 10 days after exposure.

PERCENT WHO BECOME ILL WHEN EXPOSED TO SOURCE
Less than 5%.

OUTCOME
Need for hospitalization is common. Fatality rate is 5-30%.

SOURCES: Michigan Department of Health and Human Services, U.S. Centers for Disease Control and Prevention, Emory University, U.S. National Institutes of Health

KRISTI TANNER and MARTHA THIERRY/DETROIT FREE PRESS, TRIBUNE NEWS SERVICE

Fieger files $100-million suit over Flint Legionnaires' disease cases

John Wisely and Jennifer Dixon, Detroit Free Press 7:08 p.m. EST February 2, 2016

- "Southfield lawyer Geoffrey Fieger filed a $100-million lawsuit today against McLaren Flint Hospital and the State of Michigan, saying they did nothing to combat an outbreak of Legionnaires' disease that killed at least one person during the Flint water crisis."

  (/story/news/local/michigan/flint-water-crisis/2016/01/22/legionnaires-expert-blames-spike-cases-flint-water/79203614/)

2012 Water Quality Technology Conference – Toronto, ON Canada

Nov 6, 2012

Case Studies of Legionnaires' Disease Outbreaks Related to Municipal Water Disruptions

Tim Keane, Legionella Consulting Engineer
Legionella Risk Management, Inc.,
Chalfont, PA

STANDARD

ANSI/ASHRAE Standard 188-2015

Legionellosis: Risk Management for Building Water Systems

Approved by the ASHRAE Standards Committee on May 27, 2015; by the ASHRAE Board of Directors on June 4, 2015; and by the American National Standards Institute on June 26, 2015.

This Standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the Standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE website (www.ashrae.org) or in paper form from the Senior Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from the ASHRAE website (www.ashrae.org) or from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 678-539-2129. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

 ISSN 1041-2336

ASHRAE / ANSI Standard 188-2015

- Publication Date June 26,2015
- First International Legionella Standard

Standard committee members included personnel from following groups / associations:

- CDC
- ASHE
- ASPE
- APIC
- AWT
- GSA
- IAPMO
- NSF
- PMI and
- Major Equipment Manufacturers
- Large Corporations
- Consulting Engineers

National Priorities: Impacts of Water Conservation on Water Quality in Premise Plumbing and Water Distribution Systems

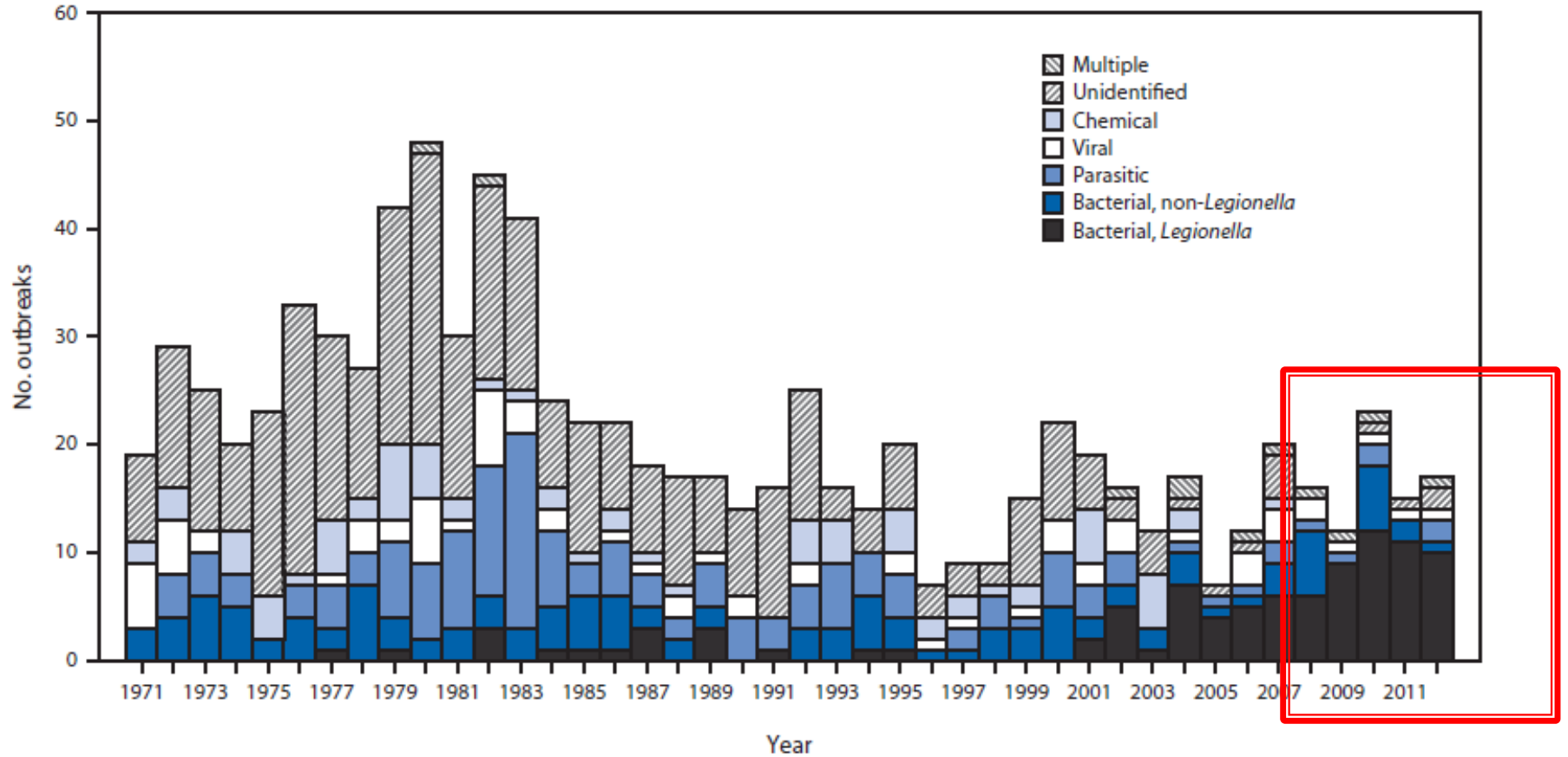
Solicitation Opening Date: February 1, 2016

U.S. Environmental Protection Agency
Office of Research and Development
National Center for Environmental Research

CDC Reported DW Outbreaks 1971 – 2012

2016 – EPA Commissions Study on Negative Impact of Water Use Reduction

8 years after Legionella becomes responsible for over 33% of DW outbreaks in 2008, then over 50% in 2009.



Key Issues

- Why OPPPs, Why Now?
- **<u>Taking Responsibility for OPPPs</u>**
- OPPPs in green buildings

- *Public Health*
  - ✓ *CDC*
  - ✓ *EPA*
  - ✓ *CMS*
  - ✓ *Joint Commission*
  - ✓ *CSP*
- *Building Design*
  - ✓ *Architectural Design*
  - ✓ *Plumbing System Design*
  - ✓ *Plumbing Component Selection*
- *Plumbing Code*
  - ✓ *Higher Temperatures*
  - ✓ *Less pipe runs*
  - ✓ *Smaller diameter pipes*

Engineering Control Strategies

1) Limiting Nutrient Strategies (e.g., AOC)
2) Secondary Residual Type and Dose
3) Upgrade Water Mains
4) Water Heater Set Point
5) In-Building Disinfection
6) ~~Thermal Shock Treatments~~
7) Pipe Material Selection
8) Flow Control
9) Heater Selection
10) Water Age

Utility

Building Level

Conclusions:

- Solutions that can be implemented by utilities
  - Maintaining higher chlorine residuals
  - Upgraded infrastructure
- Solutions that can be implemented by building owners
  - Higher temperatures
  - In building disinfection
  - Flow velocity control
  - Heater type and operation
  - Water age

2013 Fall Conference Washington, DC

Oct 14, 2013

PLUMBING MANUFACTURERS INTERNATIONAL ®

Unintended Consequences of Plumbing Codes and Regulations on Increasing Rates of Legionnaire's Disease

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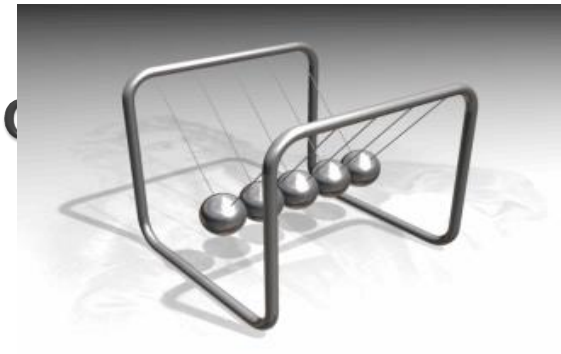
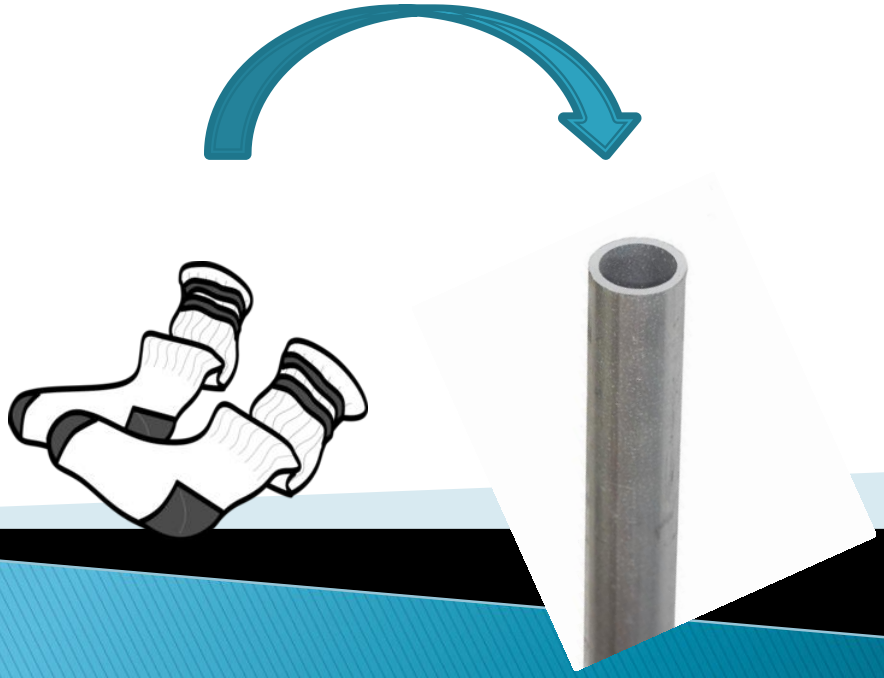


What happens when adding 0.5 gpm flow restriction to a ¾” pipe?



So what happens when we:

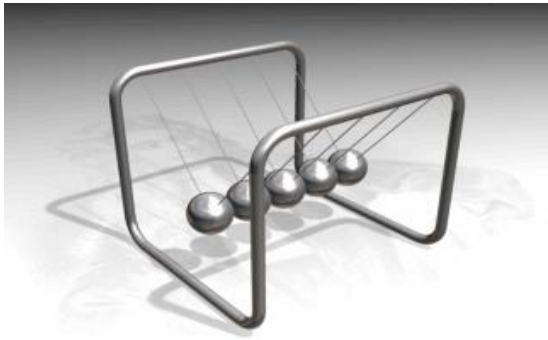
- Decrease flow rates at distal sites

  (reduced from 2.2 to 0.5gpm)

- Decrease temperatures at distal sites

  (reduced from >120 to <110°F)

- Maintain drop leg volume constant
  (no change in pipe diameters or drop leg length) (gal)



Turnover rate of a Drop Leg Reducing Water Age Volume: 1 gallons

Flow Rate (GPM)	Minutes (Min) / Drop Leg Turnover
2.5	0.4 (24 sec)
2	0.5 (30 sec)
1	1 (60 sec)
0.5	2 (120 sec)

"To the optimist, the glass is half full.
To the pessimist, the glass is half empty.
To the engineer, the glass is twice as big as it needs to be.
— Unknown

How Long Should We Wait?

Volume in the Pipe (ounces)	Minimum Time-to-Tap (seconds) at Selected Flow Rates					
	0.25 gpm	0.5 gpm	1 gpm	1.5 gpm	2 gpm	2.5 gpm
2	4	1.9	0.9	0.6	0.5	0.4
4	8	4	1.9	1.3	0.9	0.8
8	15	8	4	2.5	1.9	1.5
16	30	15	8	5	4	3
24	45	23	11	8	6	5
32	60	30	15	10	8	6
64	120	60	30	20	15	12
128	240	120	60	40	30	24

ASPE Time-to-Tap Performance Criteria

	Acceptable Performance	1 – 10 seconds
	Marginal Performance	11 – 30 seconds
	Unacceptable Performance	31+ seconds

Source: Domestic Water Heating Design Manual – 2nd Edition, ASPE, 2003, page 234

Turnover rate of a Drop Leg Reducing Water Age & Increasing Velocity

Pipe Diameter (inches)	Volume (gal) 20' drop leg	Velocity (fps) @ 1 gpm
1	0.9	0.4
3/4	0.56	0.73
1/2	0.32	1.6
3/8	0.1	3

"To the optimist, the glass is half full.
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To the engineer, the glass is twice as big as it needs to be.
— Unknown

IPC 2006

Plumbing Fixture	Maximum Discharge Temperature
Bidet	110°F
Public Hand washing Stations	85°F to 110°F
Showers	120°F
Bathtub / Whirlpool Bathtub	120°F

Legionella Risk Factors Temperature

<77ºF (25C)	no growth
72ºF (22C) to 86ºF (30C)	slow growth
86ºF (30C) to 110ºF (43C)	rapid growth
110ºF (43C) to 122ºF (50C)	slow growth
> 122ºF (50C)	no growth
> 130ºF (55C)	die in hours
> 140ºF (60C)	die in minutes

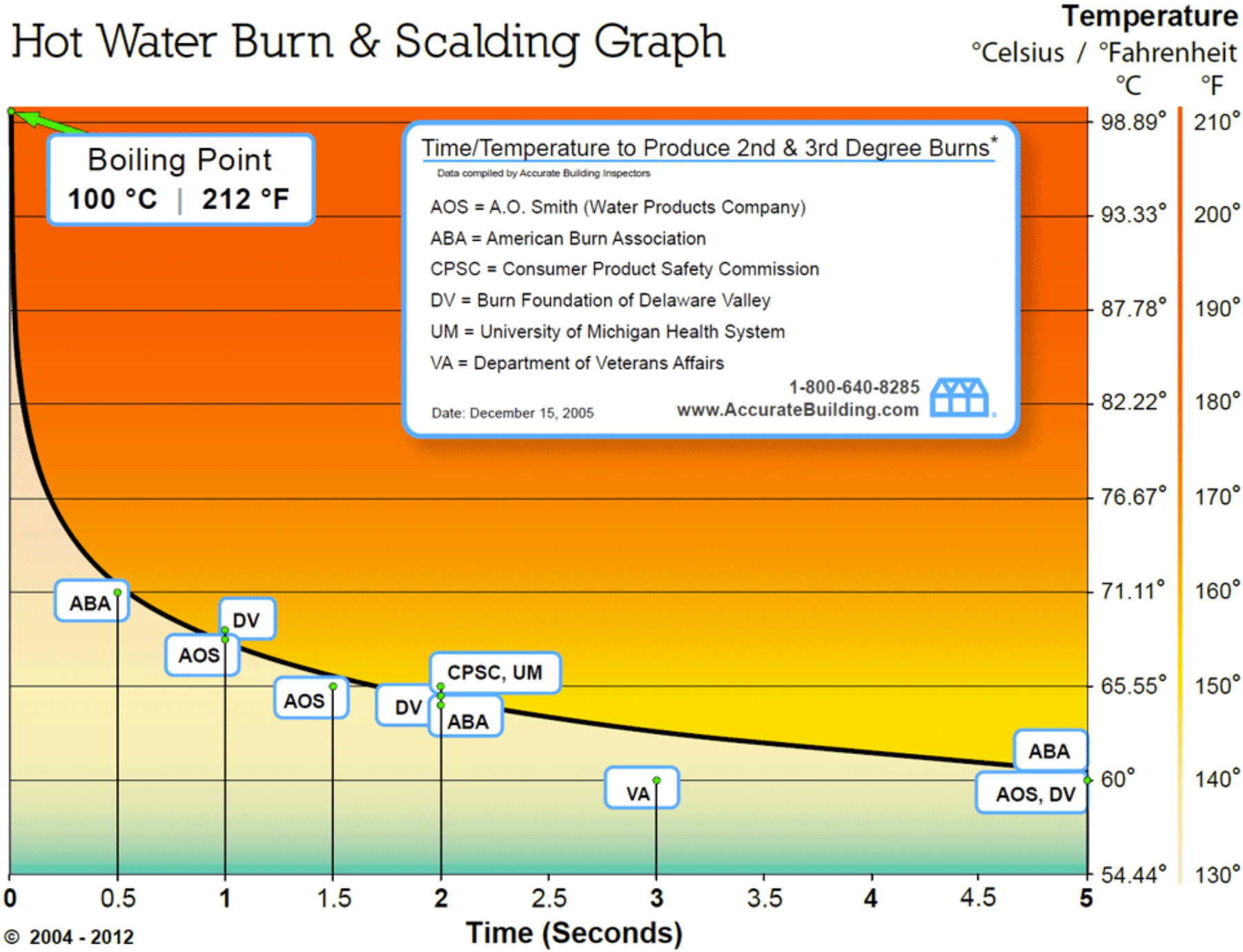
Handwashing Sink Risk Analysis

Temperatures between 85-110F are a very high risk and should **not** be recommended in code

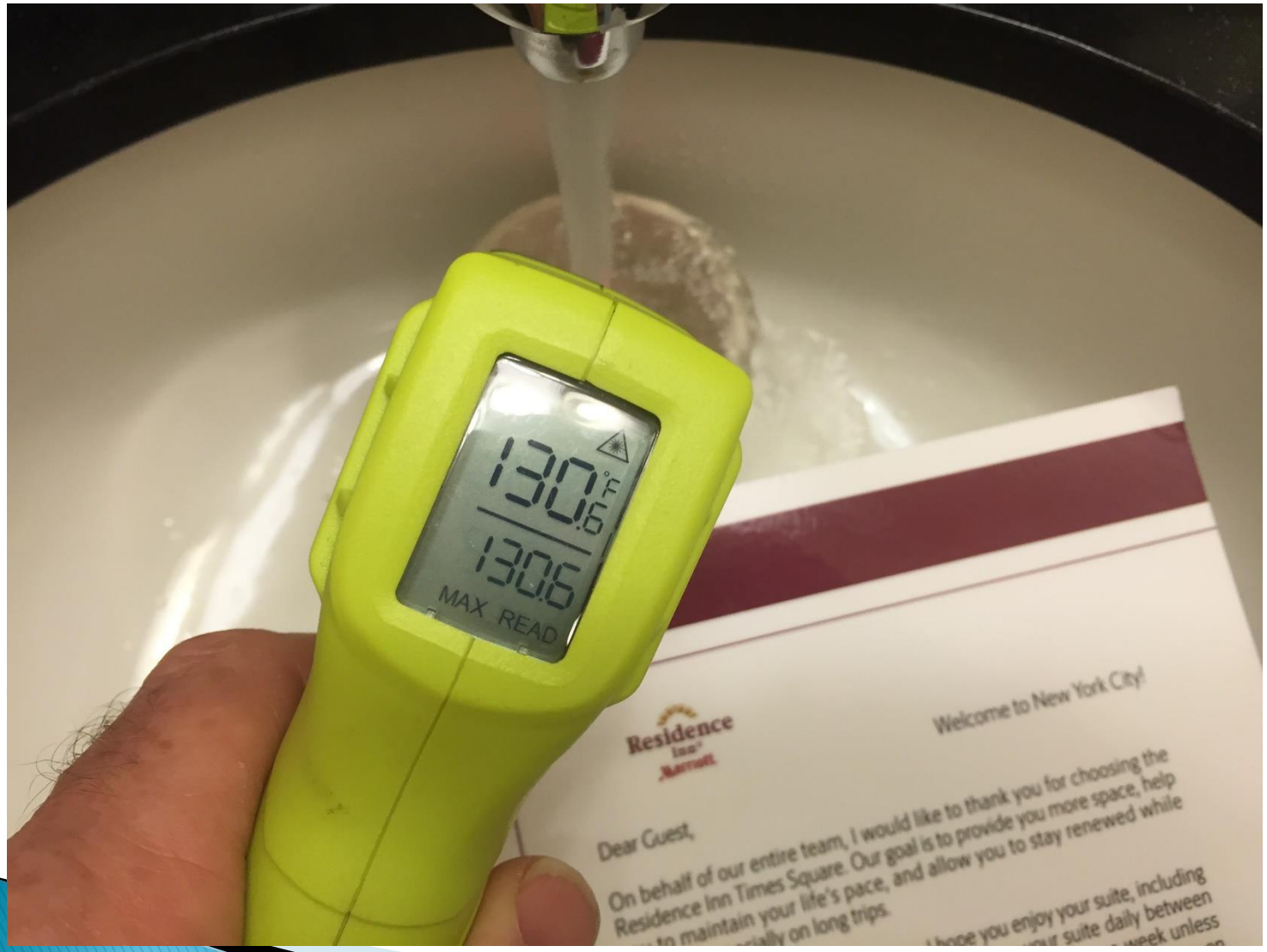
Temperature		Name	Scald Risk	Scald Time (sec)		Legionella Risk
F	C			1st °	2nd °	
< 77	< 25	Cold	No	No	No	No
77 – 85	25 – 30	Tepid Cold	No	No	No	Moderate
85 – 110	30 – 43	Tepid	No	No	No	High
110 – 122	43 – 50	Warm	No	60	300	Moderate
122 – 131	50 –55	Tempered	Very Low	5	25	Low
131 – 140	55 – 60	Hot	Moderate	2	5	Very Low
140 – 160	60 – 71	Very Hot	High	Instant	Instant	No
> 160	> 71	Disinfecting	Instant	Instant	Instant	No

Temperatures between 122 – 131 F are a very low risk and should be recommended in code

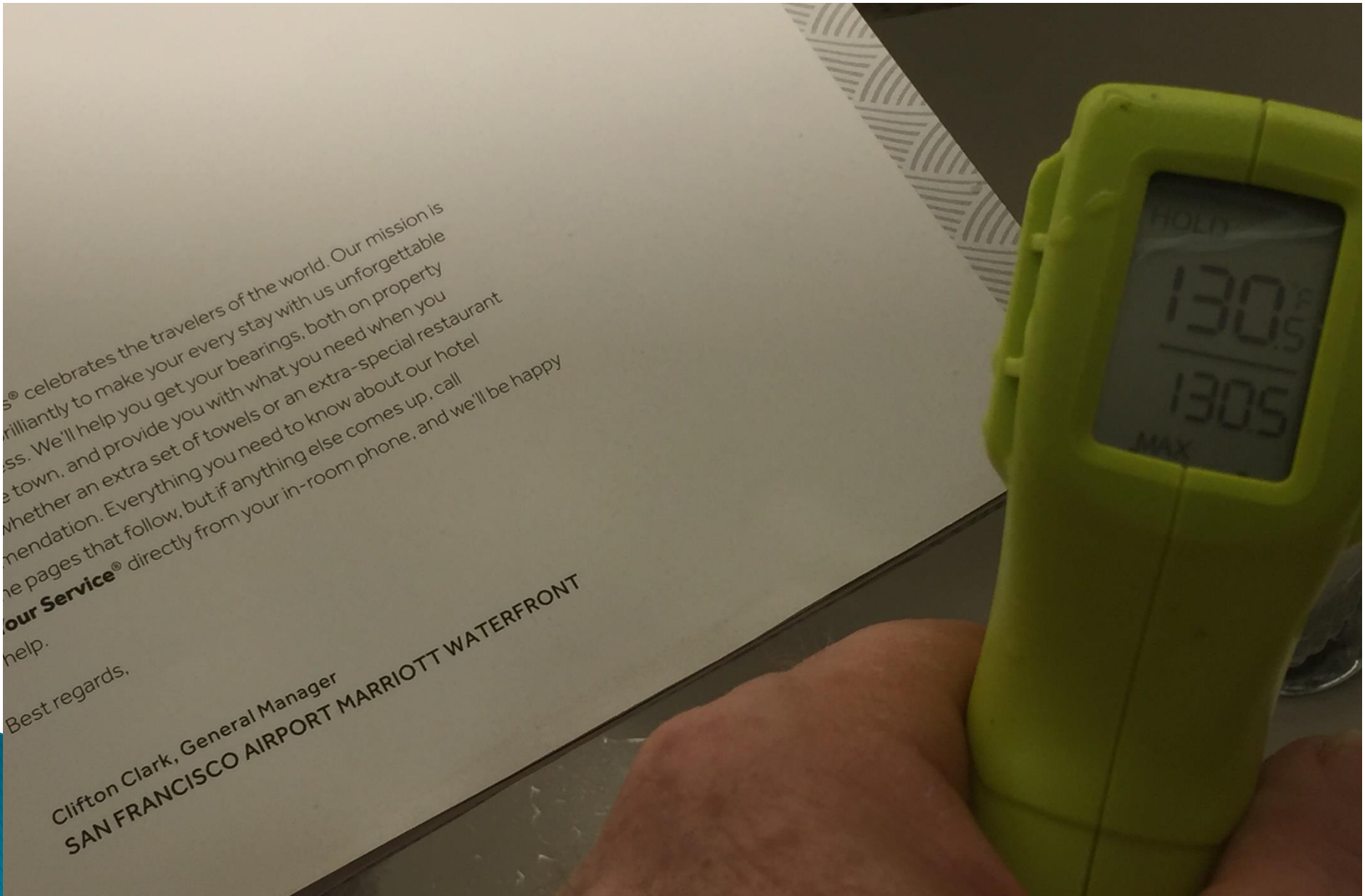
Hot Water Burn & Scalding Graph



New York City



San Francisco



Domino Effect of ASHRAE 188 on Waterborne Pathogens, Legionella and Plumbing Systems

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Domino effect

- On industry – general contractors and building owners will ask for design criteria to minimize the risk of Legionella colonization.
- On Plumbing system designers
- On equipment manufacturers.
- On litigation / liability risk for contractors and manufacturers.
- ON PLUMBING CODE CHANGES

Building Water System Design

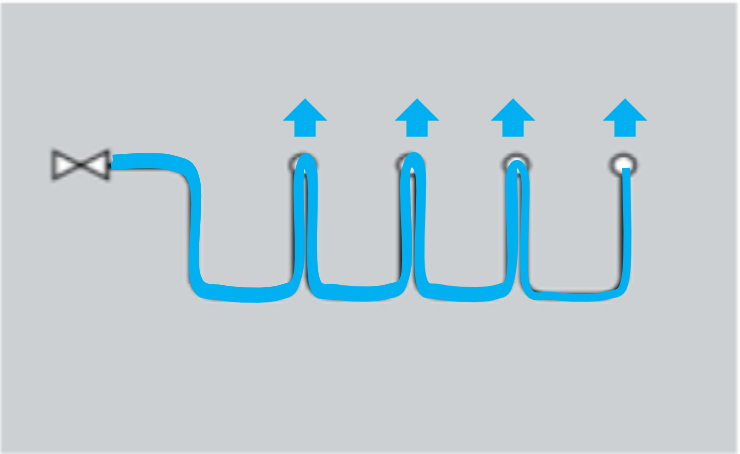
Series innovation to reduce stagnation

Double Drop Elbow

Flow Through Fittings – Series

With a Series Installation, every time a fixture is operated, fresh water flows through the supply piping of every fixture <u>upstream</u> of the fixture used.

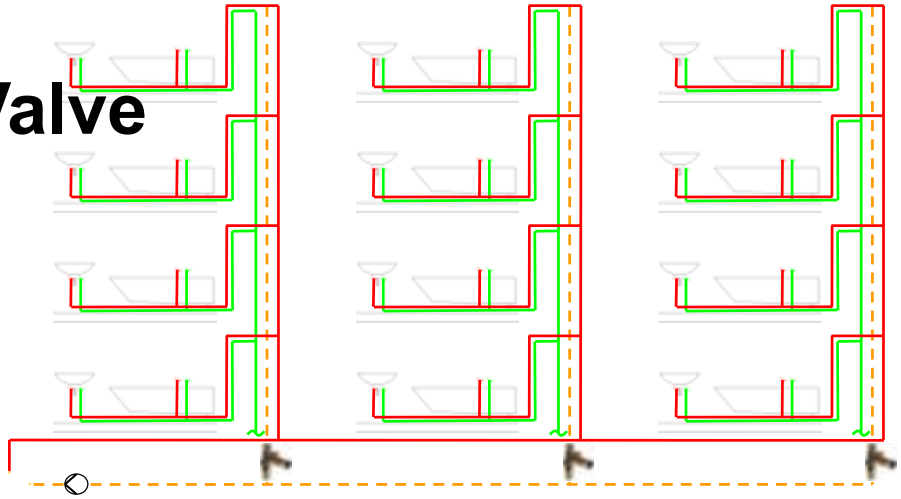
Whenever possible, the most frequently used fitting should be installed at the end of the series

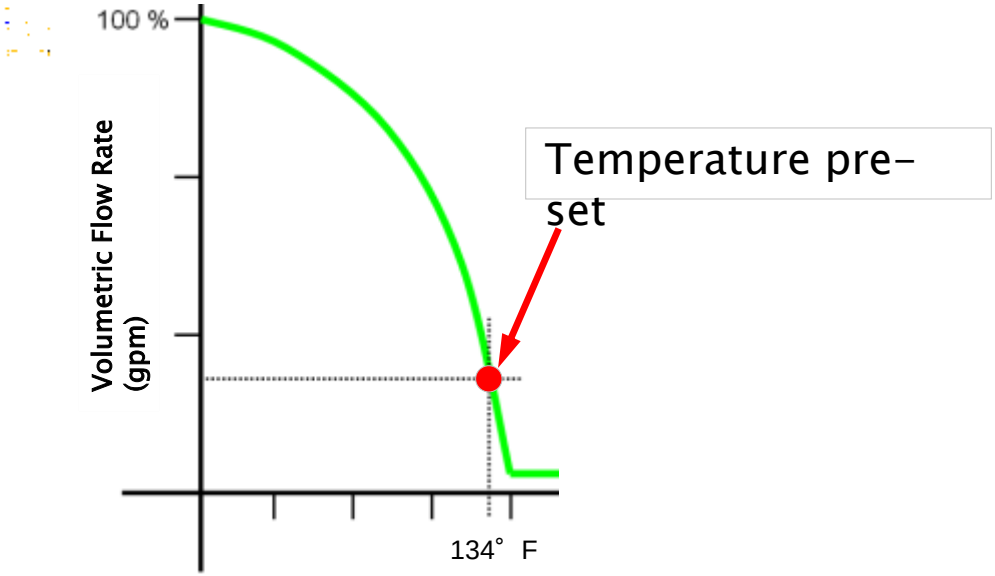


Series Installation

Design Strategies

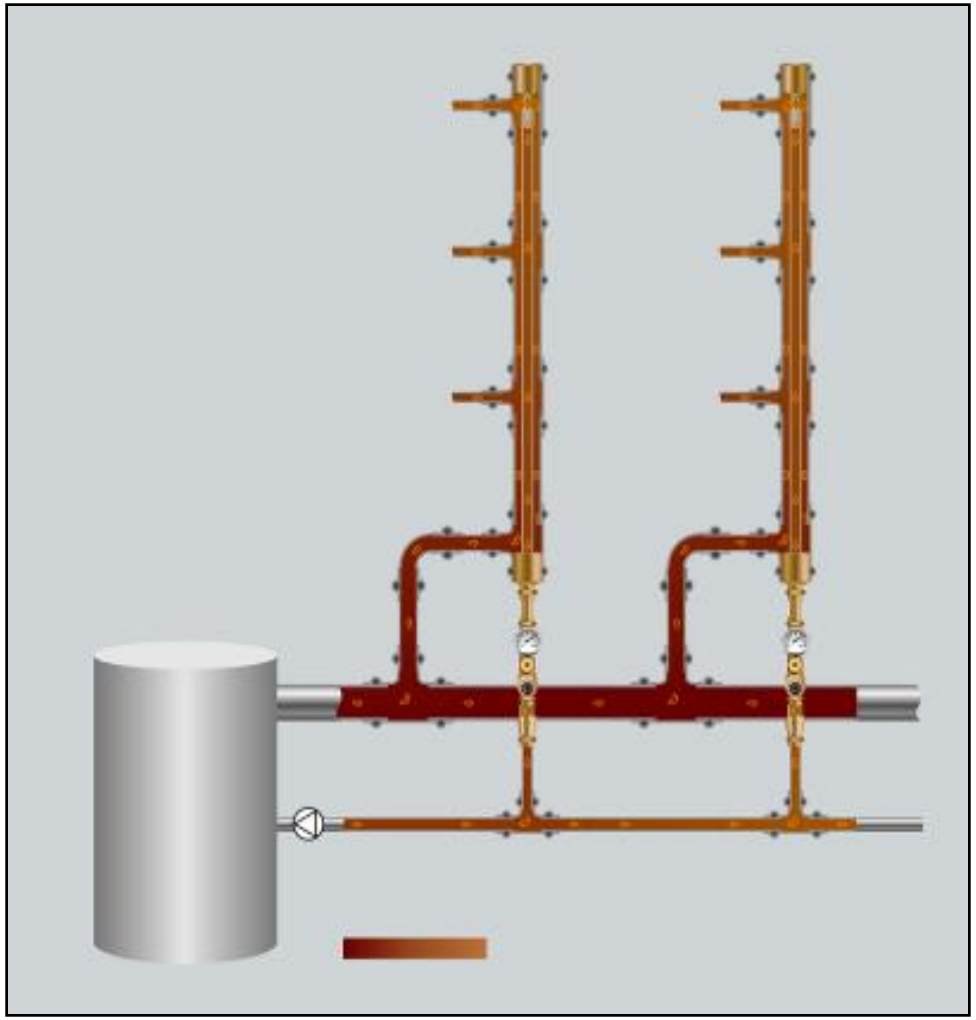
Thermostatic Recirc. Valve





Design Strategies

Internal Recirculation



Design Strategies

- Less Piping
- Smaller Circulator
- Saves Energy
- Saves Water
- Saves Material (Hangers, Fire Stops, Insulation)
- ProPress
- Fast Installation
- Less Material & Installation Cost cor o a two pipe system
- Innovative

OnDemand Tankless Heater

Commercial

- ✓ Remote fixtures eliminating hot water lines
- ✓ Low use such as school sinks.

Residential

- ✓ Stand alone
- ✓ Extra capacity
- ✓ Downstream of solar system

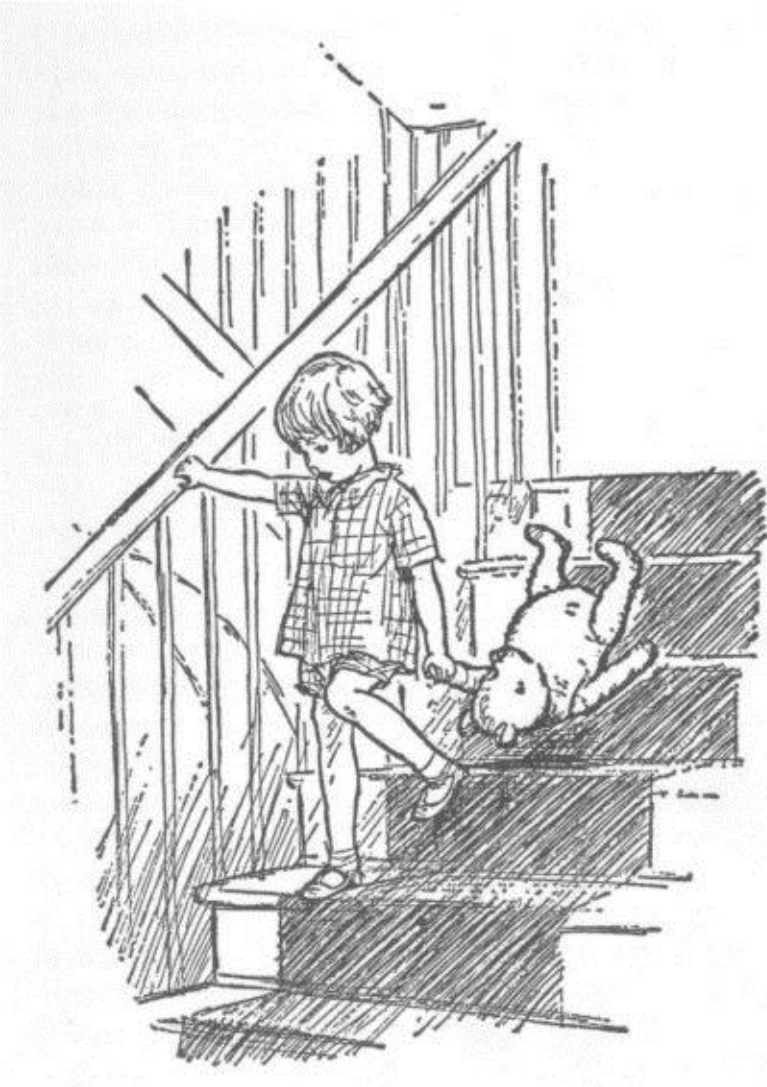
The Eye Pod

A.A. Milne insight into Process Improvement

aka Winnie the Pooh

"Here is Edward the Bear, coming downstairs now, bump, bump, bump, on the back of his head, behind Christopher Robin.

It is , as far as he knows, the only way of coming downstairs, but sometimes he feels that there is really another way, if only he could stop bumping for a moment and think of it."



Water Quality, Water Savings and the Water-Energy Nexus Three Issues, One Solution?

Absolutely!

This group of Academic, Energy and Legionella Experts Strongly Agree

Water and energy saving measures, well designed, will not facilitate OPPP's, but rather can reduce their risk.
But we need several things, most importantly code changes for temperature and pipe sizing.

By

Marc Edwards, Gary Klein & Tim Keane